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CRADA Number ORNL 95-0344

Development of Aluminum
Bridge Deck System with
Reynolds Metals Company

Final Report

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Prepared by the
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Oak Ridge, Tennessee 37831-6285
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BRIDGE DECK SYSTEM WITH
REYNOLDS METALS COMPANY**

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C. R. Brinkman
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DEVELOPMENT OF ALUMINUM BRIDGE DECK SYSTEM WITH REYNOLDS METALS COMPANY

C. R. Brinkman and H. Wayne Hayden*
Oak Ridge National Laboratory

ABSTRACT

Currently, there are many structurally-deficient and obsolete bridges in the U.S. highway system. The expected cost for repair and replacement is enormous; therefore, more cost-effective materials and construction methodology must be sought. Reynolds Metals Company * formed a vertical consortium to develop and market a cost-effective, innovative, lightweight, corrosion resistant aluminum bridge deck system based on hollow aluminum shapes that could be welded together in the shop to form deck panels. Panels would be shipped to the construction sites for final assembly, which uses connections along longitudinal edges.¹ These deck panels would replace conventional steel or concrete panels. An epoxy-gravel wearing surface would be applied to the top side of the deck to provide a durable, skid-resistant surface. However, before this deck system could be widely utilized, the overall structural integrity had to be fully demonstrated. Reynolds Metals Company and Oak Ridge National Laboratory (ORNL) entered into a Cooperative Research and Development Agreement (CRADA) to conduct a number of fundamental investigations into potentially critical technical areas over approximately a four-year period. The technical areas that were investigated at ORNL were selected to take advantage of unique talents and capabilities, and were as follows:

High cycle fatigue tests were conducted on candidate mechanical deck-to-bridge joints using four different fasteners to determine fatigue lives under tension-tension loading.²

Through thickness residual strain mapping, studies were conducted using neutron diffraction on a welded joint between two aluminum sections that comprise the deck structure.³

Wearing integrity tests were conducted on aluminum and resin-rock (pea gravel) surface coated samples to determine if the wear surface would remain attached to the deck under normal service conditions. Bending high cycle fatigue tests were conducted at temperatures of -20°F to 150°F. Resin cure time, mixture ratios, wear surface thickness, and aluminum surface preparation were also varied. Ultimate and endurance limits were determined.^{4,5} Ultrasonic scans were used to characterize debonding that occurred in localized areas between the aluminum and resin.

Turn-of-nut method was investigated to determine the integrity of proposed slip-critical bolted aluminum joints to be used to assemble aluminum bridge deck sections. These studies showed that the same rules used in tightening bolts in steel structures were also applicable to aluminum structures.⁶

Bending fatigue studies were conducted on welded aluminum plates to simulate loading conditions in aluminum bridge deck system weldments. Weld defects were introduced prior to testing either during the weld process or by machining. Degradation in fatigue life occurred as a result of these defects and the reduction in life was dependent upon defect length.

* This work was supported through a Cooperative Research and Development Agreement with Reynolds Metals Company (Richmond, Virginia), sponsored by the Laboratory Technology Program, Office of Energy Research, U.S. Department of Energy, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corporation.

STATEMENT OF THE OBJECTIVES

To perform materials and structures testing and evaluation studies to facilitate use of aluminum extrusions as a bridge decking material.

CRADA BENEFIT TO DOE

Test results, methods development, and analytical evaluation of test information were performed to aide in the use of aluminum extrusions and epoxy-pea gravel wear surface composites as bridge decking materials.

TECHNICAL DISCUSSION

Work performed by ORNL is discussed in the abstract given above. Reynolds Metals Company prepared and tested some of the specimens referred to in the above studies. Further, they conducted wear surface durability, full deck panel tests, as well as developed the specific deck designs of several bridges now in service.⁷

INVENTIONS (MADE OR REPORTED)

No inventions were made or reported, however, primary focus was upon test method and data development as well as using unique capabilities existing at ORNL. Reynolds Metals put several bridge decks in service which will be monitored over the long term to confirm expected durability.

COMMERCIALIZATION POSSIBILITIES

Several highway bridges are now in service using technology developed under this CRADA agreement.

PLANS FOR FUTURE COLLABORATION

Reynolds Metals Company has had a change in direction with respect to projects they are planning to pursue. Their present plans do not envision fabrication of aluminum extrusions for use as bridge decking.

CONCLUSIONS

A number of projects developed under this CRADA were successfully concluded which should further facilitate use of aluminum extrusions as a bridge decking material. These projects included results from surface durability studies, mechanical properties testing of welded and bolted joints, non-destructive evaluation of aluminum epoxy interfaces and welded joints, and use of turn-of-nut method for slip-critical joints.

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